Bank Supervision, Regulation, and Efficiency: Evidence from the European Union

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Abstract

This paper investigates the dynamics between key regulatory and supervisory policies and various aspects of commercial bank efficiency and performance for a sample of 22 EU countries over 2000-2008. In the first stage of the analysis we measure efficiency by employing the Data Envelopment Analysis (DEA) technique. In addition, we employ two distinct accounting ratios to capture the costs of intermediation (net interest margin) and cost effectiveness (cost-to-income ratio). Our regression framework includes truncated regressions and generalized linear models. Moreover, we carry out a sensitivity analysis for robustness using a fractional logit estimator. Our results show that strengthening capital restrictions and official supervisory powers can improve the efficient operations of banks. Evidence also indicates that interventionist supervisory and regulatory policies such as private sector monitoring and restricting bank activities can result in higher bank inefficiency levels. Finally, the evidence produced suggests that the beneficial effects of capital restrictions and official supervisory powers (interventionist supervisory and regulatory policies) on bank efficiency are more pronounced in countries with higher quality institutions.

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1. Introduction

Banking is one of the most regulated industries in the world.[1] The deregulation process in the European Union (EU) during the 1990s has considerably liberalized banks' structural and conduct rules. This has been accompanied by a parallel increase in prudential regulation, particularly in relation to a minimum capital adequacy. Yet, financial regulation emerges as a highly controversial issue.

A number of studies, prior to the recent crisis, have emphasized the role of capital standards in preventing bank failure and in safeguarding customers and the whole economy from negative externalities (e.g. Hovakimian and Kane, 2000; Gorton and Winton, 1995; Rochet, 1992). On the other hand, regulation may interfere with the efficient operation of banks. In this respect, whenever regulation is implemented with the aim of restricting or limiting banks' activities, their conduct of business and the efficiency with which they operate are affected. This is because banks may react to a higher regulatory burden by engaging in riskier activities and invest in ways that circumvent regulation. This could ultimately affect economic performance (e.g. Jalilian et al., 2007).

While regulation can take the form of detailed and precise prescriptive rules, it is often inaccurate. Capital adequacy rules for example, may specify how much capital each bank should hold, but if such rules do not truly reflect the risks involved they could unintentionally induce banks to hold either too much or not enough capital. Insufficient capital increases the danger of bank failure whilst excessive capital imposes unnecessary costs on banks and their customers with adverse implications for the efficiency of the banking system. Furthermore, economic theory provides conflicting predictions about the impact of regulatory and supervisory policies on bank performance (e.g. Barth et al., 2004; 2007; 2010).

The existing evidence on the relationship between different types of regulations, supervisory practices, and bank performance is rather limited and most of it focuses on the experience of

[1] See, for example, Santos (2001). Bank regulation typically refers to the rules that govern the behavior of banks, whereas supervision is the oversight that takes place to ensure that banks comply with those rules. It is common to distinguish between systemic, prudential and conduct of business regulations (Goodhart et al. 1998; Llewellyn, 1999).

individual countries (e.g., Barth et al., 2004; Beck et al., 2006; Berger et al., 2008). Furthermore, it typically relies on standard accounting measures of bank efficiency and performance (Barth et al., 2003a,b; and Demirguc-Kunt, et al., 2004). Barth et al. (2006), for example, investigate the impact of a broad range of regulatory and supervisory practices on bank development, performance, and stability as well as on the degree of corruption in bank lending. They provide a detailed account of such practices for over 150 countries, and focus on capital regulations, official supervision, and market discipline. A recent spate of studies rely on alternative frontier methods in considering the relationship between regulation and bank efficiency (e.g. Fries and Taci, 2005; Grigorian and Manole, 2006; Pasiouras et al., 2009).

Nonetheless, the existing empirical evidence is inconclusive and scant, especially considering the timeliness of the issue and the significant increase in the demand for regulation produced by the recent financial turmoil and bank insolvencies. In the EU, which is the focus of this paper, the Basel II Accord was implemented at the beginning of the crisis in 2007, and it was based on the pillars of minimum capital requirements, supervisory review, and market discipline. Indeed since then the Basel Committee responded by taking measures to strengthen the Basel II framework and approved for consultation a package of proposals to strengthen global capital and liquidity regulations with the goal of promoting a more resilient banking sector.[2]

This paper provides an investigation of the impact of regulatory and supervisory approaches on bank efficiency in the EU during the period 2000-08. In addition to the traditional approach of relying on accounting ratios we use the non-parametric Data Envelopment Analysis (DEA) technique to capture information about banks' efficiency. We employ generalized linear models and a truncated regression model combined with bootstrapped confidence intervals using a recently developed econometric framework by Simar and Wilson (2007). We also conduct a sensitivity analysis using Papke and Wooldridge's (1996) fractional logit estimator to cross-check our results. Our evidence

[2] See http://www.bis.org/press/p091217.htm.

suggests that there is a strong link between various forms of banking regulation and supervision and bank efficiency. The effect on bank efficiency appears to change with the type of regulation, indicating that strengthening official supervisory power or increasing capital requirements can have a discernible positive impact on bank efficiency while restrictions on bank activities and excessive private monitoring can adversely affect the efficient operation of banks.

The next section provides a selective review on the relationship between regulation and bank performance and efficiency. Section 3 presents the methodology and the data sources. Section 4 discusses the empirical results, and Section 5 concludes.

2. Literature review

While relatively little evidence exists on the relationship between regulatory and supervisory policies and various aspects of bank performance and efficiency, the literature on bank regulatory practices is copious. Theoretical studies emphasize the relative importance of capital adequacy requirements in bank regulation (Dewatripont and Tirole, 1993). One of the main functions of capital is the 'risk sharing function' which views capital as a buffer that allows for the orderly disposal of assets and shields debt holders from losses. If capital is adequate then assets will not have to be sold in 'fire sale', a situation that would affect both depositors' losses and, as a consequence, deposit insurance. A second key function of bank capital is that it provides owners and managers with incentives to take less risk (Gale, 2010).

Nevertheless, analysts disagree as to whether the imposition of a minimum capital requirement actually reduces risk-taking incentives (Blum, 1999). Official supervision can reduce market failure by monitoring and disciplining banks thus weakening corruption in bank lending and improving the functioning of banks as intermediaries (Beck et al., 2006). Powerful supervisors, however, may affect negatively bank performance when their concerns for their own private welfare dominate over concerns for the social welfare (Becker, 1983; Shleifer and Vishny, 1989). No

consensus also exists on whether market monitoring has advantages as compared to official supervisions and capital requirements (Herring, 2004).

Barth et al. (2004) provide empirical evidence on the impact of specific regulatory and supervisory practices on bank development, performance and stability using survey data for a sample of 107 countries. The results suggest that there is no statistically significant relationship between capital stringency, official supervisory power, bank performance and stability. In contrast, the produced evidence indicates that encouraging and facilitating private monitoring can boost bank performance. On balance their results indicate that restrictions on bank activities not only can be detrimental for banking performance but also increase the probability of banking crises.

Similarly, Demirguc-Kunt et al. (2004) investigate the impact of bank regulations, market structure, and national institutions on the cost of financial intermediation as measured by accounting ratios (net interest margin and overhead costs). They use the databases by Barth et al. (2001b; 2004) for 1400 banks operating in 72 countries over 1995-1999. The results document that tighter regulations on banking services and activities increase the costs of financial intermediation. In contrast, Fernandez and Gonzalez (2005) consider the same time span for a sample of listed banks and provide evidence suggesting that in countries with low accounting and auditing requirements more power on official supervisory authorities may reduce risk-taking behavior from the perspectives of managers. Moreover, they indicate that higher restrictions on bank activities can diminish the probability of a banking crisis. Beck et al. (2006) use data on 2500 firms across 37 countries to examine the relationship between supervisory strategies and corporate financing obstacles. Their results show that strengthening the power of supervisory agencies may actually reduce the integrity of bank lending with adverse implications on the efficiency of credit allocation. Thus, private monitoring may have a positive impact on the banking industry in terms of efficient operations and sounder banks.

All the studies reviewed above rely on accounting measures to infer the performance and efficiency of the banking sector. More recent empirical studies use frontier analysis to compute sophisticated measures of bank performance and then relate them to the effects of regulatory practices. In a cross-country analysis, Pasiouras (2008) employs Tobit regression models to assess the impact of several types of regulations on bank-specific DEA efficiency scores for a sample of 715 commercial banks operating in 95 countries in 2003. The results suggest that market discipline is significant in facilitating bank technical efficiency. In a more recent study, Pasiouras et al. (2009) investigate the link between bank regulations and parametric cost and profit efficiency levels for 615 publicly listed commercial banks operating in 74 countries over 2000-2004. Their findings substantiate the role of market discipline and of supervisory power in increasing both profit and cost efficiency, while the results on capital requirements and restrictions on bank activities are mixed.

Similarly, recent international empirical evidence by Barth et al. (2010) indicate that tighter restrictions on bank activities exert a negative impact on bank efficiency (measured using the non-parametric frontier analysis) while greater capital restrictions are marginally and positively associated with bank efficiency. Barth et al. (2010) also find that, although there is no significant relation between official supervisory power and bank efficiency, there is a significant and positive relationship between the latter and supervisory authority independence. The analysis is based on an international sample of 4050 bank observations operating in 72 countries during 1999-2007. The evidence broadly supports the role of market discipline. It also shows that the impact of different aspects of regulations on bank performance and efficiency is mixed.

Overall, although several studies have measured the effect of bank regulation and supervision on bank efficiency, the majority of these studies tend to cover large international cross-country data samples, and none of them offer alternative measures of efficiency. The present study advances the existing literature in two ways. First, it tests three alternative measures of performance, namely productive (in)efficiency, costs of intermediation and cost effectiveness for 22 EU countries over the

period 2000-08. Second, it provides a robust procedure (bootstrapping) for non-parametric estimates and a sensitivity analysis for robustness using a fractional logit estimator. The next section provides the details of the models used for the empirical analysis.

3. Model specification and methodological issues

3.1 Estimating productive efficiency: the DEA approach

While the extant literature on bank regulation and supervision relies mostly on accounting ratios for measuring bank performance, recent analyses highlight the advantages of frontier efficiency measures as indicators of bank performance and efficiency (see for extensive reviews of the literature e.g. Berger and Humphrey, 1997; Berger, 2007; Fethi and Pasiouras, 2010; and Hughes and Mester, 2010).

The efficiency scores used in our empirical analysis are constructed using an input-oriented DEA approach. DEA models can be either input- or output-oriented according to whether the focus is on input minimization while keeping a given output level or output maximization given levels of the inputs (see, for more details, Coelli et al., 2005). Following the most recent banking literature, we employ an input-oriented DEA since banks are typically under pressure to minimize costs, where outputs are normally constrained by the market demand, and therefore cannot be controlled for. Specifically, we use the input-oriented DEA with Variable Returns to Scale (VRS) developed by Banker et al. (1984), which allows for the possibility that the production technology of banks in the sample may exhibit increasing, constant or decreasing returns to scale.[3]

This approach to modeling financial intermediation has been widely adopted in the literature, based on the assumption that bank managers may have higher control over inputs (e.g. personnel expenses) rather than outputs (e.g. loans, etc.). More specifically, in industries where the emphasis is on cost-control, the choice of an input orientation is natural because the input quantities appear to be

[3] The VRS specification adds a convexity constraint to the original Charnes, Cooper and Rhodes's (1978) model.

the primary decision variables (Ferrier and Valdmanis, 1996).[4] DEA employs linear programming and makes some fairly general assumptions about the production technology (Ray, 2004), in order to provide an estimate of the Farrell (1957) efficiency measure for each bank in the sample.[5] The efficiency scores are estimated relative to a common best-practice frontier by pooling the data across units estimated separately for each year. This approach allows us to estimate efficiency differentials not only between commercial banks within a country but across countries as well using the same benchmark.

3.2 Regression framework

In the second stage of the analysis the aim is to uncover, by means of regression methods, the underlying relationship between the calculated efficiency levels, regulatory and supervisory policies and a variety of bank- and country- specific factors. Specifically, we estimate the following three models:

$$INEFF_{i,k} = \alpha + \beta_1 S_i + \beta_2 B_{i,k} + \beta_3 C_i + YEAR_t + \varepsilon_{i,k} \quad (1a)$$

$$NIM_{i,k} = \alpha + \gamma_1 S_i + \gamma_2 B_{i,k} + \gamma_3 C_i + YEAR_t + \varepsilon_{i,k} \quad (1b)$$

$$C/I_{i,k} = \alpha + \delta_1 S_i + \delta_2 B_{i,k} + \delta_3 C_i + YEAR_t + \varepsilon_{i,k} \quad (1c)$$

where i refers to country i, k indexes bank k, S_i is a vector of bank regulatory and supervisory indicators in country i, $B_{i,k}$ is a vector of bank-specific characteristics for each bank k in country i,

[4] It is necessary to point out that output- and input-orientated models will estimate exactly the same frontier and therefore identify the same set of efficient banks. It is only the efficiency measures associated with the inefficient banks that may differ between the two methods. To date, the theoretical literature is inconclusive as to the best choice among the alternative orientations of measurement.

[5] For a systematic introduction to DEA methodology, see among others, Ray (2004).

C_i is a vector of country-specific control variables in country i, $YEAR_t$ is a yearly dummy variable and $\varepsilon_{i,k}$ is the error term.

The dependent variable *INEFF* in equation (1a) is the managerial inefficiency measure, measuring how far the bank is from the estimated efficient frontier. In other words, efficiency is the ability of a bank to fully exploit the available production technology and relates to superior management or technologies. It is a relative measure that implies the best-practice banks are by definition 100 per cent efficient, while the others are characterized as inefficient relative to them.[6] We use bank inefficiency rather than efficiency as dependent variable in our model as described in equation (1a), to be able to provide a consistent interpretation of results, since the other two dependent variables (equations 1b and 1c) are costs of intermediation (proxied by net interest margins) and cost effectiveness (the cost-to-income ratio).

These are two accounting ratios that proxy for the level of bank performance as in Barth et al. (2004; 2006). In particular, the NIM, in equation (1b) is the net interest margins over interest bearing assets. Similarly to Barth et al. (2006), in this paper we adopt the interpretation of NIM as a signal of inefficient intermediation and greater market power that allows banks to charge higher margins. In other words, the NIM measures the gap between what the bank pays savers and what the bank receives from borrowers, and thus pertains to the traditional borrowing and lending operations of the bank.

The dependent variable in equation (1c) is the cost-to-income ratio, C/I, used to capture cross-bank differences in the efficiency with which banks are managed. High costs signal unwarranted managerial perquisites and market power which is inconsistent with efficient bank intermediation (Barth et al., 2006). Cost inefficiencies and market power may be reflected in high costs. Therefore, the results from considering all three performance measures can be used for

[6] Specifically, $INEFF_{i,k} = 100 - EFF_{i,k}$, that is, if a bank presents an inefficiency score of 0.15, it means that it wastes 15% of its costs or alternatively it uses 85% of its resources efficiently relative to best-practice banks (that are 100% efficient).

comparing different concepts of bank efficiency and to assess how productive efficiency estimates relate to standard financial ratios of efficiency/performance.

We use the regulatory and supervision variables of Barth et al. (2001b; 2006; 2008); the bank-specific variables are drawn from BankScope and the country-specific controls are from the alternative World Bank. Further details regarding the sources of data and variables can are provided in Section 3.3.

The vector S_i contains the regulatory and supervision explanatory variables as follows:

$$S_i = (CAPRQ_i, SPOWER_i, ACTRS_i, PRMONIT_i) \quad (2)$$

where CAPRQ, is an index of capital requirements accounting for both overall and initial capital stringency. This index is calculated on the basis of nine questions with higher values indicating greater capital stringency. The Official Supervisory Power variable, SPOWER, measures the ability of supervisory authorities to take specific action in banking decisions to prevent and correct problems. It is calculated by adding 1 for each 'yes' and 0 for each 'no' to questions relating to supervisory power, with higher values indicating greater power of supervisory authorities for involvement in banking decisions.

ACTRS, measures the degree to which banks may engage in real estate investments, insurance underwriting and selling, brokering and dealing in securities and all aspects of the mutual fund industry. This variable ranges from 0 to 4, with higher values indicating greater restrictiveness. Empirical evidence suggests that higher activity restrictions may result in lower efficiency levels, by reducing competition and limiting economies of scope (Barth et al., 2001a,b; 2003b). Thereby, a negative sign between efficiency and activity restrictions is expected.

The variable PRMONIT measures the degree of information that is released to officials and the public, auditing related requirements and whether credit ratings are required. This variable is

constructed by adding 1 for each 'yes' and 0 for each 'no' to ten questions relating to private monitoring, with higher values indicating more informative bank accounts. Evidence suggests that regulations enhancing private monitoring can significant increase bank efficiency (Pasiouras, 2008; Barth et al. 2006, 2004).

The regression specifications in equations (1a-1c) account for bank specific $B_{i,k}$ and country specific C_i control variables with the corresponding vectors defined as follows:

$$B_{i,k} = (LNTA_{i,k}, LIQ_{i,k}, EQAS_{i,k}) \tag{3}$$

$$C_i = (Z-SCORE_i HERF_i, \Delta GDP_i, VOICE_i, CORR_i, GOVERN_i, FINDEV_i FOREIGN_i) \tag{4}$$

The vector, $B_{i,k,}$ (equation 3) includes three key bank-specific variables: size, measured as the natural logarithm of banks' total assets (LNTA); liquidity, that is captured by a crude ratio between total loans and total deposits (LIQ); and finally capitalization, proxied by the equity to assets ratio (EQAS). The vector of control variables in equation (4), C_i contains measures of risk, market and economic conditions, and institutional environment. The probability of risk of insolvency is proxied by the Z-score[7], which measures how many standard deviations' profits must fall below its mean to bankruptcy. Higher values of the Z-score are associated with lower probabilities of failure. Thus, the more volatile the asset returns, the lower the Z-score. Empirical studies tend to find a significant relationship between banks' risk taking incentives and performance (e.g. Konishi and Yasuda, 2004; Stiroh, 2004).

[7] We construct this indicator per country and time by aggregating the banks' balance sheet data and define Z-score as (ROAA + equity/assets)/sd(ROA). The standard deviation (volatility) of ROA, sd(ROA), is estimated as a 5-year moving average. This variable is taken from Fitch's BankScope database (financial structure 2008, v4 – World Bank) and is on a country specific basic. See Lown et al. (2000) for details.

To account for market condition we use a structural indicator, the Herfindahl index, which is measured as the sum of squared market shares (in terms of total assets) of each bank in the sample.[8] Since the macroeconomic environment is also likely to impact on banks' efficiency levels, we also include the average annual growth rate of GDP per capita (GDPGR). A high level of GDPGR captures the cyclical conditions of the macroeconomic environment. It is also expected to capture the implications for bank efficiency stemming from operating in different economic environment, as demand for financial products depends on the level of economic activity.

The vector of institutional control variables in the efficiency equation includes the following variables: voice and accountability **(**VOICE**);** control of corruption (CORR); government-owned banks (GOVERN) financial development (FINDEV) and foreign-owned banks (FOREIGN). Voice and accountability is an indicator of the degree to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association and a free media. This variable is drawn from Kaufman et al. (2009) dataset on institutional development. Control of corruption measures the extent to which public power is exercised for private gains, with larger values indicating better control of corruption by government officials. This variable is also derived from Kaufman et al. (2009). The government-owned banks variable is used as proxy for the degree of state-owned banks. It is calculated as the fraction of the banking system's assets that is held by banks that are more that 50 percent owned by the government.

Financial development is measured by the claims on domestic real non-financial sector by deposit money banks as a share of GDP and attempts to capture the importance of the services provided by financial institutions relative to the size of the economy. It is drawn from the World Bank financial structure database.[9] Foreign-owned banks are used to account for the share of the

[8] The Herfindahl index, however, is not a good proxy for bank competition (see OECD, 2010). In addition, the relationship between concentration, competition and bank efficiency is by no means straightforward (see e.g. Casu and Girardone, 2006; Schaeck et al., 2009).
[9] The development of the financial systems was examined using data from Beck et al. (2009).

banking system's assets that are 50 per cent or more foreign-owned (FOREIGN).[10] Finally, the set of YEAR dummy variables in equations (1a–1c) controls inter alia for other macroeconomic, regulatory and technological changes. In addition, we re-estimate our models by including a CRISIS dummy variable to capture the effects of the global financial crisis.

Given that the estimation of Equation (1a) involves a dependent variable that emerged from the DEA analysis, we use a truncated estimator with bootstrapped confidence intervals that allow for valid inference.[11] Specifically, we employ the Simar and Wilson's (2007) parametric regression bootstrap, which incorporates the parametric structure and distributional assumptions of Equation (1a). This method allows for the computation of bootstrapped confidence intervals for the parameter estimates $\hat{\beta}_{1-3}$. This is achieved by using 2000 bootstrap replications. Accordingly, when NIM and C/I are the dependent variables, we estimate the Equations (1b and 1c) using Generalized Linear Models (following Barth et al., 2006). We also cross-validate our results by re-estimating Equations (1a-1c) using Papke and Wooldridge's (2006) fractional logit estimator (discussed in Section 4.3).[12]

3.3 Data and Input-Output Definition

The dataset used for obtaining the DEA efficiency scores consists of individual bank data sourced from unconsolidated statements drawn from BankScope by Bureau van Dijk. We focus on commercial banks operating in 22 EU countries over 2000-2008, namely: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, France, Germany, Hungary, Italy, Latvia, Lithuania,

[10] The foreign ownership was examined using data drawn from the World Bank database by Barth et al (2001b; 2006; 2008).

[11] A variety of regression methods are employed in the literature for examining the sources of bank efficiency such as OLS and Tobit estimators, with the Tobit assumed to be the most appropriate due to the bounded nature of the efficiency score (see, for example, Coelli et al. 2005). However, recently, Simar and Wilson (2007) have demonstrated that the Tobit estimator is inappropriate in this framework and instead suggest the use of a truncated estimator with bootstrapped confidence intervals. They also provide Monte-Carlo evidence that this approach ensures consistent inference in the second-stage regression.

[12] We also cross-validate our results by re-estimating the second-stage regression model specified in Equations (1a-1c) without Luxembourg to contrast whether or not its inclusion introduces noise on the results. Overall, the removal/inclusion of Luxembourg does not affect our key findings. The results without Luxemburg are not reported in the tables but are available upon request from the authors.

Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden and United Kingdom.[13] The data have undergone substantial editing to avoid inconsistencies, reporting errors and double counting of institutions. Moreover in order to obtain a relatively homogenous dataset and further detect and remove the potential outliers from the sample, we apply the Jackstrap methodology.[14] Finally, we exclude extreme outliers, which we define as banks where the basic accounting variables are more than four standard deviations from the mean sample.[15]

Implementing the aforementioned screening methods, results in an unbalanced panel of 5,227 commercial bank observations. Table 1 presents the number of bank observations by country and year.[16] No single country appears to dominate our sample. Germany is the most represented with approximately 18.6 per cent of banks, followed by France (about 15.6 per cent).

<Insert Table 1 about here>

A crucial step in evaluating relative efficiency in banking is the selection of appropriate inputs and outputs. Following Berger and Humphrey (2007), we adopt the 'intermediation' approach, which views banks as intermediaries that employ labor, physical capital and deposits to produce different types of loan accounts. Accordingly, we consider personnel expenses, total fixed assets, and deposits and short term funding as inputs and total loans and other earning assets as outputs. Capturing the non-traditional activities of banks is essential, especially when dealing with banking institutions in the European area characterized by a wide scope of activities. Hence, we consider the

[13] Due to unavailability of data or/and missing values for a significant number of banks we had to exclude Bulgaria, Finland, Greece, Ireland and Romania from our EU dataset.
[14] See, for more details, Chortareas et al. (2011).
[15] This leads to the exclusion of 59 bank observations. The results hold even when we include these extreme observations in the dataset.
[16] On average in 2005 there were 45% foreign banks in the EU according to Barth et al. (2008) database. Unsurprisingly (with the exception of Luxembourg) the countries with the highest percentage are typically from the New Member States block that was incorporated in the EU in 2004, such as Estonia, Hungary and Slovakia (97% on average).

fee-based financial services as a third output. The descriptive statistics for the inputs and outputs used in the DEA efficiency measurement are presented in Table 2.

<Insert Table 2 about here>

We specify three groups of explanatory variables. The first group contains bank regulatory and supervisory indicators, focusing on Official Supervisory Power, Capital Regulatory Index, Private Monitoring and Activity Restrictions. As mentioned in Section 3.2, we obtain information on bank regulation and supervision from the World Bank database by Barth et al. (2001b) Version I, and updated by Barth et al. (2006, 2008) with Versions II & III. The data source for the second group of variables reflecting bank-specific characteristics is BankScope by Bureau van Dijk. The third group of explanatory variables contains country-specific factors that are expected to influence banks' efficiency. The data are from the worldwide governance indicators of the World Bank by Kaufman et al. (2009) and the World Bank financial structure database by Beck et al. (2009).

In addition to the three regulatory and supervisory datasets mentioned above, we use the Worldwide Governance Indicators of the World Bank by Kaufman et al. (2009) to control for institutional factors that may influence efficiency. Higher values of these indicators correspond to better governance, with scores ranging between -2.5 and 2.5. Table 3 presents the descriptive statistics for the dependent and explanatory variables used in the regression analysis. On average, the 'old' EU15 block tends to have higher quality institutions compared to the ten New Member States (NMSs).

Given that one of our aims is to test for the effects of market discipline and private monitoring and that information on this specific variable is not available for all 22 countries and for all the years, we construct a sub-sample that comprises 16 countries.[17]

[17] The countries that we exclude from this sub-sample are Cyprus, France, Germany, Malta, Spain and United Kingdom.

<Insert Table 3 about here>

4. Empirical results

4.1 Productive efficiency levels

We estimate the banks' efficiency scores relative to a common best-practice frontier by pooling the data across countries. This approach allows for estimating efficiency differentials not only between banks within a country but across countries as well. Overall, the results show relatively high average productive inefficiency levels of about 22 per cent, which is broadly in accordance with previous bank efficiency studies for Europe (e.g. Goddard et al., 2001; Lozano-Vivas et al., 2002; Casu and Molyneux, 2003; Fethi and Pasiouras, 2010).

4.2 The relationship between regulation, supervision and bank performance

To consider the effects of regulatory and supervisory practices on bank performance we regress the productive efficiency scores, the net interest margins and the cost-to-income ratios, on a set of regulatory and supervisory variables, while controlling for several bank- and country-specific factors Following Simar and Wilson (2007), we estimate the truncated regression model given in Equation (1a) using maximum likelihood. The parameter estimates and their bootstrap confidence intervals (estimated using 2000 bootstrap replications) are presented in Table 4.[18] The reported estimates of equations (1b and 1c) result from applying the generalized linear models methodology to the full sample of banks in a cross sectional regression over 2000-2008.

[18] The results about the confidence intervals around each estimated parameter are available from the authors upon request.

Each of Tables 4-6 reports regression results derived from the estimation of eight models. The first column presents the basic regression model that includes bank-specific control variables, economic growth, competitive market conditions, and the bank regulatory and supervisory variables (model 1). The next three columns include country-specific variables to control the effect of institutional characteristics on bank efficiency (models 2-4).[19] Model 5 accounts for the effect of foreign-owned banks and model 6 corresponds to re-estimating the basic model with dummies to control for potential effects of the recent financial crisis and the risk of insolvency. The last two columns test the inclusion of the private monitoring variable (models 7 and 8). As mentioned above, due to the unavailability of data, we run these last two models for a sub-sample of 16 EU countries.

<Insert Tables 4-6 about here>

Our results indicate that, when significant, capital requirements and more powerful supervisors increase bank efficiency. In particular, CAPRQ displays a negative and statistically significant coefficient in all regression models when NIM and C/I are the dependent variables (Tables 5-6). Official capital adequacy regulations appear to play a crucial role in aligning the incentives of bank owners with depositors and other creditors. Theoretical models, however, disagree over the effects of capital requirements on risk-taking incentives. As Barth et al. (2004) emphasize, it is extraordinarily difficult for regulators and supervisors to set capital standards that mimic those that would be demanded by well informed, undistorted private-market participants. Previous empirical evidence on capital requirements tends to find a positive relationship with bank efficiency (e.g., Barth et al., 2010) but in general the nature of this relationship is not straightforward. Barth et al. (2004) and Demirguc-Kunt et al. (2004) find no robust link between bank efficiency (measured by

[19] In order to avoid problems of multicollinearity, we use the maximum condition index (as suggested by Belsley et al., 1980) and the variance inflation factors (VIF) as measures of collinearity to select the control variables that could reasonably be included in the analysis. We thank an anonymous referee for suggesting this additional test. The full results are not reported, but are available with the authors upon request.

NIM and Overhead Costs) and capital requirements. Pasiouras (2008) find evidence of a positive association between capital requirements and efficiency, but this is not always statistically significant. Pasiouras et al. (2009) find a positive impact of capital requirements on cost efficiency and a negative one on profit efficiency. Convincing arguments exist indeed, that higher capital requirements may result in lowering the probability of bankruptcy, improving the information availability, which in turn increase the efficient operation of banks (e.g. Demirguc-Kunt and Huizinga, 1999; Berger and Bonaccorsi di Patti, 2006). Nevertheless, other authors find that capital requirements increase risk-taking (e.g., Blum, 1999) and argue that stricter capital standards may lead banks to substitute loans with alternative forms of assets (e.g., VanHoose, 2007).

Similarly, the coefficient of the variable SPOWER, when significant, is negative across all models thus suggesting that official supervision can improve the efficiency of banks' operations. The only exception is when we include the private monitoring variable (columns 7-8). This result is probably associated with the fact that the last model uses a subset sample of countries, excluding some of the largest EU banking sectors (Germany, France and Spain). The bulk of existing empirical evidence on the relationship between official supervision and performance provides mixed results (Barth et al., 2004, 2007; Pasiouras, 2008; Pasiouras et al., 2009). Indeed it represents a point of heated debate between the proponents of the "public interest view" and those of "private interest view" (e.g., see Beck et al., 2006). Governments with powerful supervisors may use this power to improve the corporate governance of banks and reduce corruption in bank lending which in turn improves the efficient operation of banks (Stigler, 1971; Beck et al., 2006). The relationship between bank performance and official supervision, however, turns negative when re-estimating the model for a different sample with less developed countries. A possible explanation could be that enhancing the power of supervisors in less developed financial systems may reflect excessive government involvement, which may result in a decrease in the integrity of bank lending with adverse implications on the efficiency of credit allocation (Barth et al., 2004; Beck et al., 2006).

Turning to the variables explaining market discipline, our results uncover a strong and statistically significant relationship with inefficiency. To recall, higher values for ACTRS imply greater restrictions on banks' activities in each country. The results of a positive and statistically significant relationship with all measures of performance indicate that restricting banks from engaging in security activities is strongly associated with lower bank efficiency and performance. This result is in accordance with previous findings in the banking literature (see among others, Barth et al., 2004, 2006, 2010; Demirguc-Kunt et al, 2004). Specifically, the literature suggests that restrictions on bank activities and general impediments to bankers in their business conduct reduce the efficiency of bank operations without a corresponding benefit in terms of other measures of bank performance.

Focusing on the variable explaining private monitoring, higher values for PRMONIT imply more informative and transparent banks' balance sheets. As Tables 4-5 (models 7-8) show, an unambiguously positive and significant impact of PRMONIT on inefficiency exists. This is particularly strong when INEFF and NIM are the dependent variables. In other words, our findings suggest that fortifying private sector monitoring can actually impede the efficient operation of banks. This is in contrast with previous literature that provides evidence in favor of private monitoring practices (Barth et al., 2004, 2006; Pasiouras, 2008). Although our results should be interpreted with caution since the data were available for a smaller sample of countries, there are several possible interpretations of these findings. One is that the requirements for information releases which facilitate the monitoring of banks have an indirect effect on bank efficiency. Moreover this effect depends on a number of factors, including the credibility of this information. At the same time, however, the banks' effort to produce this information has clearly costs that count negatively in their efficiency assessment.

Turning to the vector of bank-specific variables, bank size appears to be an important factor that drives the differences in efficiency across banks, which is documented by a negative and

statistically significant sign for the LNTA coefficient. This finding is consistent with previous studies on European countries (e.g. Stavarek, 2004; Altunbas et al. 2007; Yildirim and Philippatos, 2007). The liquidity variable (LIQ) constructed as total loans over total deposits capture liquidity risk. This variable has a significant and positive relationship with the cost of intermediation (NIM). The INEFF and C/I display a negative relationship with the LIQ variable but this is statistically insignificant.

The results for bank capitalization (EQAS) reveal a significantly negative relationship in all regressions and for all specifications with INEFF and C/I. This finding confirms that higher capital ratios are related with greater efficiency and is consistent with the argument that higher capitalization contributes to alleviating agency problems between managers and shareholders. Shareholders in this case have greater incentives to monitor management's performance and ensure that the bank is run efficiently (Eisenbeis et al., 1999). On the other hand, our evidence suggests that higher capital ratios are also associated with greater costs in terms of cost of intermediation (NIM), a finding which is in line with Barth et al. (2006). Thus the efficiency benefits of higher capitalization come at a cost in terms of accounting ratios.

As expected, we find that the probability of bankruptcy (Z-SCORE) is negatively associated with all of our performance measures, indicating that countries with more efficient banking institutions have relative lower insolvency risk. This result is consistent with previous empirical studies (e.g. Konishi and Yasuda, 2004; Stiroh, 2004).

As far as the macro environment is concerned, we find some interesting relationships. The results suggest a positive and significant association of market share with inefficiency. In particular, the coefficient for the Herfindahl index (HERF) enters positively in all of our specifications with INEFF and NIM. This result is in line with previous studies that focus on structural market imperfections arising from imperfect competition which may cause market power and lax market discipline in concentrated markets (Yildirim and Philippatos, 2007; Berger and Hannan, 1998).

The annual growth of per capita GDP (GDPGR) variable enters with a positive sign in all the specifications with INEFF as dependent variable. This result indicates that banks in expanding markets may be less efficient in controlling their costs, thereby resulting in lower efficiency levels. On the other hand, the same banks may be able to increase their performance in terms of costs. This result is documented by a negative and significant coefficient of GDPGR in most of the cases with NIM and C/I.

Consideration of the institutional control variables reveals that banks operating under more open institutional frameworks are more likely to achieve higher efficiency levels. In particular, the variable VOICE, that measures the degree of freedom of expressions and free media in a country's system, is negatively associated across all the regressions, with productive inefficiency, profits and costs, indicating that more developed and democratic systems are associated with more efficient banking sectors. Unsurprisingly, the variable capturing corruption in lending (CORR) is negatively associated with inefficiency at the 1 percent levels of significance across all regressions, indicating that bank managers in non-corrupt markets are able to achieve greater operational efficiency levels. Our results show that the GOVERN variable is associated with less inefficient banking industries. This is in line with previous studies (Stiglitz, 1994). As in most cases, the coefficient for FINDEV shows a negative and significant sign in all specifications, implying that bank managers in developed countries have better access to technology and can monitor and screen their costs, which in turns improves the efficient operation of banks (Pasiouras et al., 2009). Finally, the significance of the variable capturing foreign-owned banks (FOREIGN) suggests that a foreign banking presence may spur domestic banks to operate efficiently. This result is in line with previous studies (Pasiouras et al., 2009).

4.3 Sensitivity analysis

McDonald (2009) argues that DEA efficiency is not the outcome of a truncated process but rather the outcome of a fractional logit process (it takes values between zero and one) and thus not a latent variable. This motivates us to re-estimate the regression models specified in Equations (1a,b,c) for robustness purposes, using the Papke and Wooldridge (1996)'s 'fractional logit' estimator.

In this context the application of Papke and Wooldridge's (1996) quasi-likelihood estimation method allows us to cross-check our results in terms of the underlying data-generating process (DGP), under which the DEA efficiency estimates are generated by a truncated DGP (Simar and Wilson, 2007) or are simply described by a fractional logit process (McDonald, 2009). The sensitivity analysis is carried out on all three Equations (1a-1c) because of the same fractional nature of the two accounting ratios. Overall, the findings from the Papke and Wooldridge (1996) method (Table 7) corroborate the key results from our basic regression models (model 1 and model 8) reported in Tables 4-6. Specifically, we continue to find a positive and significantly high effect of ACTRS on banks' inefficiency across all three models. CAPRQ remain negative and statistically significant, a result particularly strong when NIM and C/I are the dependent variables. Finally, the finding for official supervisory power across all three models remains robust, indicating that countries with power supervisors may use this power to improve the efficient operations of banks.

5. Conclusions

This paper contributes to the existing literature by empirically examining the impact of regulatory and supervisory policies on bank efficiency and performance. We focus on a sample of banks operating in 22 European countries over the period 2000-2008. We obtain efficiency scores using an input-oriented Data Envelopment Analysis methodology and we also consider performance measures calculated from traditional accounting ratios, namely net interest margin and cost-to-income. Using

both types of performance measures enhances the robustness of our analysis but also allows direct comparability of our results with those of previous studies.

Our results suggest that the variables capturing capital requirements and supervisory power are positively associated with improved bank performance. Strengthening official supervisory power or increasing capital requirements can have a discernible positive impact on bank efficiency through a number of channels, including the reduction in the likelihood of financial distress, lessening agency problems and market power. The variables capturing regulatory restrictions on bank activities and private monitoring appear to be affecting adversely the efficient operation of banks.

Considering the economic and institutional environment within which bank supervisory and regulatory policies impact on bank performance, we find that larger banks operating in countries with less concentrated and more developed systems tend to have relatively higher levels of efficiency. Moreover, our results are consistent with the view that the functioning of national political systems may affect the efficient operation of banks. Controlling for these broader, national characteristics, can explain cross-bank differences in terms of efficiency. Furthermore, our evidence shows the potential perils in terms of bank efficiency from excessive requirements for market monitoring in the attempt to strengthen market discipline. Yet there is no doubt that the recent global economic and financial crisis puts this discussion on a new basis rendering the conflicting approaches that either view regulation as a panacea or demonize it as too general and simplistic to be useful. The emerging challenge is to consider which specific aspects of regulatory and supervisory policies affect bank performance and how their implementation and effectiveness is related to the broader institutional framework.

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Table 1

Data frequency distribution by country and year

	Austria	Belgium	Cyprus	Czech Republic	Denmark	Estonia	France	Germany	Hungary	Italy	Latvia	Lithuania
Number of bank observations by year												
2000	33	22	6	9	46	4	111	123	10	33	15	8
2001	33	13	5	12	43	5	109	106	9	32	14	6
2002	37	16	7	10	38	5	96	103	9	19	15	7
2003	34	20	5	10	42	4	89	107	10	19	18	7
2004	36	21	6	14	45	4	90	100	10	67	18	9
2005	33	19	5	15	49	5	84	110	13	133	16	9
2006	29	13	4	13	51	3	80	110	15	97	15	10
2007	29	12	6	13	45	5	83	101	12	88	16	10
2008	24	13	6	9	12	3	67	102	10	64	13	5
Total	288	149	50	105	371	38	809	962	98	552	140	71

	Luxembourg	Malta	Nether-lands	Poland	Portugal	Slovakia	Slovenia	Spain	Sweden	UK	Total
Number of bank Observations by year											
2000	86	5	6	19	6	7	8	21	6	17	601
2001	74	5	8	14	6	5	5	14	17	17	552
2002	66	5	7	15	7	7	5	15	16	17	522
2003	64	5	6	14	6	6	6	11	15	23	521
2004	61	7	10	22	7	6	6	12	16	35	602
2005	57	4	8	24	8	14	14	32	16	36	704
2006	63	3	5	20	10	8	12	39	17	32	649
2007	56	6	4	19	10	9	11	22	15	32	604
2008	36	3	5	16	6	8	8	16	15	31	472
Total	563	43	59	163	66	70	75	182	133	240	5,227

Table 2
Selected descriptive statistics of bank inputs and outputs[a]

Variable	Mean	St.dev	Median	Minimum	Maximum
Inputs					
Personnel expenses	48.8	10.19	147.6	0.080	2,044.0
Total Fixed Assets	34.0	5.4	119.3	0.010	3,687.0
Deposits and Short-term Funding	4518.1	797.6	13910	0.200	172,920
Outputs					
Total Loans					
Total Other Earning Assets	2735.6	405.98	8440.0	0.500	94,013
Fee-based Income	2667.9	326.7	9250.1	0.050	116,379

[a] Values in € million.

Table 3
Variables Employed in the cross sectional regressions:[a]

Symbol	Definition	Mean	St.dev.	Min	Max	Median
Dependent Variables						
INEFF	Productive Inefficiency measure using the Data Envelopment Analysis (DEA) methodology (VRS)	0.22	0.15	0.00	0.84	0.23
NIM	(Interest Income - Interest Expenses) / Interest-Bearing Assets	0.03	0.02	0.00	0.49	0.02
C/I	Cost / Income Ratio	0.63	0.17	0.03	0.99	0.63
Regulatory and Supervisory Variables						
CAPRQ	Capital Regulatory Index	5.83	1.64	3.00	9.00	6.00
SPOWER	Official Supervisory Power	9.39	2.26	5.00	14.00	9.00
ACTRS	Activity Restrictions	7.23	2.61	3.00	12.00	7.00
PRMONIT[b]	Private Monitoring	7.91	0.97	5.00	9.00	8.00
Bank-Specific Control Variables						
LNTA	Logarithm of Total Assets	7.03	1.67	2.90	12.30	6.87
LIQ	Total Loans / Total Deposits	0.73	1.77	0.00	80.06	0.67
EQAS	Shareholder's Equity / Total Assets	9.57	7.91	0.26	88.20	7.60
Risk of Insolvency						
Z-SCORE	Risk of Insolvency	8.91	5.61	2.42	78.38	8.42
Country-Specific and Institutional Variables						
HERF	Herfindahl index of local market concentration	0.21	0.14	0.04	0.90	0.19
GDPGR	Annual Growth rate of per capita GDP	0.03	0.02	-0.05	0.12	0.02
VOICE	Voice and Accountability	1.26	0.20	0.71	1.78	1.32
CORR	Control of Corruption	1.47	0.67	0.11	2.39	1.77
GOVER	Government-Owned Banks	10.73	15.33	0.00	42.20	3.90
FINDEV	Deposit Money Bank Assets / GDP	1.17	0.38	0.18	2.49	1.18
FOREIGN	Foreign-Owned Banks	0.30	0.33	0.00	0.99	0.16

[a] All financial variables measured in € million. Annual GDP growth is measured at constant 2000 market prices.
[b] Data for the PRMONIT variable refer to the EU16 sub-sample.
Sources: WB (Barth et al. 2001b; 2006; 2008), Governance Matters VIII (Kaufman et al., 2009), WB financial structure database (Beck et al., 2009), AMECO, Bankscope and own calculations.

Table 4. The relationship between bank inefficiency and regulation (equation 1a)

Years: 2000-2008								
Dep.Var.: INEFF	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Regulation and Supervision								
CAPRQ	0.002	0.003**	0.003**	0.003**	0.001	0.002	-0.006**	-0.013***
SPOWER	-0.004***	-0.004***	-0.004***	-0.004***	-0.001	-0.003**	0.001	0.003**
ACTRS	0.003***	0.001	0.001	0.0004	0.003***	0.009***	0.004*	0.012***
PRMONIT	-	-	-	-	-	-	0.011***	0.012***
Bank-Specific variables								
LNTA	-0.034***	-0.035***	-0.035***	-0.030***	-0.029***	-0.033***	-0.034***	-0.033***
LIQ	-0.001	-0.001	-0.001	-0.001	-0.001	-0.0004	-0.002	-0.001
EQAS	-0.006***	-0.006***	-0.006***	-0.005***	-0.005***	-0.005***	-0.004***	-0.004***
Risk of Insolvency								
Z-SCORE	-	-	-	-0.0003	-	-0.001**	-0.002**	-0.002***
Country-Specific variables								
HERF	0.194***	0.217***	0.216***	0.191***	0.149***	0.182***	0.215***	0.203***
GDPGR	0.503***	0.356***	0.337***	0.061	0.687***	0.338***	0.448***	0.588***
VOICE	-	-0.053***	-	-	-	-	-	-
CORR	-	-	-0.018***	-	-	-	-	-
GOVERN	-	-	-	-0.001***	-	-	-	-
FINDEV	-	-	-	-0.032***	-	-	-	-
FOREIGN	-	-	-	-	-0.037***	-	-	-
Constant	-0.580***	-0.501***	-0.534***	0.047***	0.388***	-0.557***	-0.718***	-0.717***
Year Dummies	YES	YES	YES	YES	YES	NO	YES	NO
Crisis Dummies	NO	NO	NO	NO	NO	YES	NO	YES
Observations	5227	5227	5227	5227	5227	5227	2548	2548
Number of Countries	22	22	22	22	22	22	16	16

Note: CAPRQ= Capital Regulatory Index, SPOWER= Official Supervisory Power, ACTRS= Activity Restrictions, PRMONIT= Private Monitoring, LNTA= LN of Total Assets, LIQ= Total Loans/Total Deposits, EQAS= equity/assets, Z-SCORE= (ROA+EQAS)/St.Dev(ROA), HERF= Herfindahl Index, ΔGDP= Real GDP Growth, VOICE= Voice and Accountability, CORR= Control of Corruption, GOVERN= Government-Owned Banks, FINDEV= Deposit Money Bank Assets/GDP, FOREIGN=Foreign-owned banks, Crisis= Dummy variable that equals 1 after year 2006 and 0 otherwise, Constant= constant term.

Estimation of the models is based on Simar and Wilson (2007), Algorithm 1, using 2000 bootstrap replications for the confidence intervals of the estimated coefficients.

*p<0.1 Significance from zero at the 10% level according to bootstrap confidence intervals.

**p<0.05 Significance from zero at the 5% level according to bootstrap confidence intervals.

***p<0.01 Significance from zero at the 1% level according to bootstrap confidence intervals.

Table 5. The relationship between bank costs of intermediation and regulation (equation 1b)

Years: 2000-2008								
Dep.Var.: NIM	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Regulation and Supervision								
CAPRQ	-0.001**	-0.0002	-0.0002	0.0001	-0.001**	-0.001***	-0.001***	-0.0003
SPOWER	-0.001***	-0.001***	-0.001***	-0.0004**	-0.0003*	-0.0002	0.001***	0.001**
ACTRS	0.002***	0.001***	0.0004**	0.001***	0.002***	0.001***	0.002***	0.001***
PRMONIT	-	-	-	-	-	-	0.002***	0.002***
Bank-Specific variables								
LNTA	-0.003***	-0.003***	-0.003***	-0.002***	-0.003***	-0.003***	-0.002***	-0.002***
LIQ	0.001***	0.001***	0.001***	0.001**	0.001***	0.001***	-0.0001	-0.0002
EQAS	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
Risk of Insolvency								
Z-SCORE	-	-	-	-0.0002***	-	-0.0003***	-0.001***	-0.0004***
Country-Specific variables								
HERF	0.024***	0.031***	0.031***	0.032***	0.028***	0.026***	0.027***	0.027***
GDPGR	0.024	-0.018	-0.03	-0.073***	0.036*	-0.009	-0.004	-0.015
VOICE	-	-0.017***	-	-	-	-	-	
CORR	-	-	-0.007***	-	-	-	-	
GOVERN	-	-	-	0.0002	-	-	-	
FINDEV	-	-	-	-0.011***	-	-	-	
FOREIGN	-	-		-	-0.002			
Constant	0.035***	0.060***	0.051***	0.049***	0.035***	0.037***	0.002	0.001
Year Dummies	YES	YES	YES	YES	YES	NO	YES	NO
Crisis Dummies	NO	NO	NO	NO	NO	YES	NO	YES
Observations	5227	5227	5227	5227	5227	5227	2548	2548
Number of Countries	22	22	22	22	22	22	16	16

Note: CAPRQ= Capital Regulatory Index, SPOWER= Official Supervisory Power, ACTRS= Activity Restrictions, PRMONIT= Private Monitoring, LNTA= LN of Total Assets, LIQ= Total Loans/Total Deposits, EQAS= equity/assets, Z-SCORE= (ROA+EQAS)/St.Dev(ROA), HERF= Herfindahl Index, ΔGDP= Real GDP Growth, VOICE= Voice and Accountability, CORR= Control of Corruption, GOVERN= Government-Owned Banks, FINDEV= Deposit Money Bank Assets/GDP, FOREIGN= Foreign-owned banks, Crisis= Dummy variable that equals 1 after year 2006 and 0 otherwise, Constant= constant term.

Estimated using Generalizes Linear Models (GLM).

*p<0.1 Significance from zero at the 10% level

**p<0.05 Significance from zero at the 5% level

***p<0.01 Significance from zero at the 1% level

Table 6. The relationship between bank cost effectiveness and regulation (equation 1c)

Years: 2000-2008								
Dep.Var.: C/I	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Regulation and Supervision								
CAPRQ	-0.006***	-0.004**	-0.003*	-0.002	-0.008***	-0.006***	-0.027***	-0.020***
SPOWER	-0.006***	-0.007***	-0.007***	-0.006***	-0.002	-0.005***	0.010***	0.007***
ACTRS	0.004***	0.0001	-0.002	0.0005	0.005***	0.001	0.017***	0.006***
PRMONIT	-	-	-	-	-	-	-0.001	-0.001
Bank-Specific variables								
LNTA	-0.022***	-0.021***	-0.022***	-0.021***	-0.021***	-0.022***	-0.035***	-0.037***
LIQ	-0.0002	-0.001	-0.0003	-0.001	-0.001	-0.0004	0.0003	-0.001
EQAS	-0.003***	-0.003***	-0.003***	-0.003***	-0.003***	-0.003***	-0.006***	-0.006***
Risk of Insolvency								
Z-SCORE	-	-	-	-0.0002	-	-0.0004	-0.002***	-0.001
Country-Specific variables								
HERF	-0.028	0.016	0.013	0.025	-0.072***	-0.018	-0.012	-0.009
GDPGR	-0.453***	-0.731***	-0.771***	-1.086***	-0.039	-0.623***	-0.575***	-0.833***
VOICE	-	-0.112***	-	-	-	-	-	-
CORR	-	-	-0.038***	-	-	-	-	-
GOVERN	-	-	-	0.001***	-	-	-	-
FINDEV	-	-	-	-0.085***	-	-	-	-
FOREIGN	-	-	-	-	-0.062***			
Constant	0.909***	1.071***	1.001***	1.000***	0.882***	0.921***	0.940***	0.967***
Year Dummies	YES	YES	YES	YES	YES	NO	YES	NO
Crisis Dummies	NO	NO	NO	NO	NO	YES	NO	YES
Observations	5227	5227	5227	5227	5227	5227	2548	2548
Number of Countries	22	22	22	22	22	22	16	16

Note: CAPRQ= Capital Regulatory Index, SPOWER= Official Supervisory Power, ACTRS= Activity Restrictions, PRMONIT= Private Monitoring, LNTA= LN of Total Assets, LIQ= Total Loans/Total Deposits, EQAS= equity/assets, Z-SCORE= (ROA+EQAS)/St.Dev(ROA), HERF= Herfindahl Index, ΔGDP= Real GDP Growth, VOICE= Voice and Accountability, CORR= Control of Corruption, GOVERN= Government-Owned Banks, FINDEV= Deposit Money Bank Assets/GDP, FOREIGN=Foreign-owned banks, Crisis= Dummy variable that equals 1 after year 2006 and 0 otherwise, Constant= constant term.

Estimated using Generalizes Linear Models (GLM).

*p<0.1 Significance from zero at the 10% level

**p<0.05 Significance from zero at the 5% level

***p<0.01 Significance from zero at the 1% level

Table 7. Quasi-Likelihood estimation method

Years: 2000-2008	(1)	(7)	(1)	(7)	(1)	(7)
Dep.Var.:	**INEFF**		**NIM**		**C/I**	
Regulation and Supervision						
CAPRQ	0.006	-0.040***	-0.021***	-0.046***	-0.025***	-0.117***
SPOWER	-0.018***	0.002	-0.016**	0.032***	-0.027***	0.045***
ACTRS	0.020***	0.031***	0.062***	0.088***	0.019***	0.071***
PRMONIT	-	0.098***	-	0.064***	-	-0.005
Bank-Specific variables						
LNTA	-0.227***	-0.211***	-0.114***	-0.094***	-0.093***	-0.149***
LIQ	-0.018*	-0.012	0.015**	0.0002	-0.001	0.001
EQAS	-0.044***	-0.044***	0.014***	0.026***	-0.012***	-0.026***
Risk of Insolvency						
Z-SCORE	-	-0.005	-	-0.019***	-	-0.010**
Country-Specific variable						
HERF	0.970***	1.383***	0.812***	1.014***	-0.121	0.049
GDPGR	2.889***	3.507***	0.439	-0.085	-1.916***	-2.371***
Constant	0.062	-1.139***	-3.133***	-4.192***	1.731***	1.860***
Year Dummies	YES	YES	YES	YES	YES	YES
Observations	5,227	2,548	5,227	2,548	5,227	2,548
Number of Countries	22	16	22	16	22	16

Note: CAPRQ= Capital Regulatory Index, SPOWER= Official Supervisory Power, ACTRS= Activity Restrictions, PRMONIT= Private Monitoring, LNTA= LN of Total Assets, LIQ= Total Loans/Total Deposits, EQAS= equity/assets, Z-SCORE= (ROA+EQAS)/St.Dev(ROA), HERF= Herfindahl Index, ΔGDP= Real GDP Growth, Constant= constant term.

Estimated using Papke and Wooldridge (1996) Quasi-Likelihood estimation method.

*p<0.1 Significance from zero at the 10% level.

**p<0.05 Significance from zero at the 5% level.

***p<0.01 Significance from zero at the 1% level.